METHOD AND DEVICE FOR HANDLING LOCATION-BASED SERVICES

5   Background of the Invention:

Field of the Invention:

The invention relates to a method for location-based services.
The invention also relates to a device for carrying out the
method according to the invention. The invention finds its
10   most advantageous application in wireless radio systems.

Current services are closely tied to particular networks;
subscribers use codes which specify these networks. Most of
these networks allow roaming in other access networks and
15   subscribers have the option of using more than one network,
for example by means of a multimode terminal or also via
different terminals. On the other hand, various application
servers offer interesting services. These should be
independent of the basic network and the changing network
20   provider. The trend is toward international service providers
who do not want to be impaired by local circumstances. It
would be advantageous, therefore, to be able to provide a
server which can hide these differences.

25   Location-based services currently being offered allow a
subscriber to be located. Services which want to deal with

more than one subscriber, for example, different "identities" of a person, or unknown identities in a particular area independently of the network used need a current database with a multiplicity of information items about the networks and the

5   regions covered by the networks.

Current 3GPP (3rd Generation Partnership Project, www.3gpp.org) protocols are oriented towards location-based services that handle few subscribers. Services which should

10   cover all registered subscribers, for example, statistical analyses with a detailed local accuracy or services limited to particular, relatively small regions, produce a large amount of signaling messages and thus trigger many locating processes. Furthermore, the implementation is not set up for a

15   higher density of interrogation with respect to privacy concerns and the protection of the privacy sphere.

Examples of services affected by this are:

▪ emergency information for a district: for example closing a

20   park, fire alarm, warning against hazards

▪ advertisements for a region: opening of a new business, beginning of an event in a few minutes ...

▪ triggering of a service when the user enters a particular area: e.g. offering special information, changing to a

better (or more advantageous) connection such as WLAN, Bluetooth, etc.

- triggering of a service when the user remains at the same place for a particular period: e.g. queuing at a check-out or in front of an entrance, looking at an advertisement (poster), waiting at a stop...

- the user can be informed when he approaches a particular place, for example a restaurant or a hotel

- the user is informed when he approaches a particular other user or a device: friend, colleague, team-mate, parking ticket dispenser...

- the user is informed when a person or device is leaving a region: theft protection, child leaving party, etc.

- location-dependent charging: in particular, the subscriber must be informed that the charging changes when he leaves or enters a region

- statistical analyses such as determination of the number of devices in a region, for example, for detecting a traffic jam, responding to the increased demand for public transport after the end of a mass event such as a concert, a sports event, etc.

To date, location-dependent services are still in the introductory phase and are therefore not used particularly

frequently. Many of the services specified above have not yet been implemented or can only be implemented with poor resolution on the basis of information currently available in a network such as the cellID (identification of a cell of a

5   cellular network) or LAC (location area code - a larger location area formed of cells). In the near future, only network-specific services will be offered and an open interface is currently not provided. OMA/LIF (Open Mobile Alliance, Location Interoperability Forum,

10   www.openmobilealliance.org) and 3GPP are only beginning to define the extensions for location-dependent triggering.

Furthermore, the demand for internetwork services does not yet exist to a great extent since there are currently only a few

15   subscribers who use different access networks side-by-side. However, it is already apparent that, for example, an alternative utilization of GPRS (General Packet Radio Services) and WLAN (Wireless Local Area Network) is becoming more and more popular.

20

Hitherto conceivable solutions would be:

- cyclic polling of the terminals. However, since this can involve a large number of devices, a high data flow is generated

- involving all subscribers such as broadcast SMS. No special selection of subscribers for one service possible (e.g. only foreign subscribers).

5   Summary of the Invention:

It is accordingly an object of the invention to provide a method and a device for supporting location-based services which overcome the above-mentioned disadvantages of the heretofore-known devices and methods of this general type and

10   which specify a solution for an improved offering of location-dependent services.

With the foregoing and other objects in view there is provided, in accordance with the invention, a method for

15   handling a location-based service in a limited geographic area for a plurality of subscribers, wherein the limited geographic area is served by at least two devices for determining a geographic position of mobile radio users, the method which comprises:

20   receiving, in a central network element, an inquiry from the location-based service concerning an identity of the subscribers in the limited geographic area;

requesting, with the central network element, a current information item about the subscribers active in the limited

geographic area from the at least two devices for determining

the geographic position of mobile radio users; and

delivering, with the central network element, the information

to the location-based service.

5

In other words, the invention relates to a method for handling

a location-based service for a limited geographic area (also

referred to as "area" in the text which follows) which is

served by at least two devices for determining the geographic

10   position of mobile radio users (GMLC) for a plurality of

subscribers in this geographic area.

The location-based service (LCS) sends an inquiry about the

identity of subscribers in a geographic area (area) to a

15   central network element (LAS1). The central network element

then obtains the current information about the subscribers

active in the limited geographic area from the at least two

devices for determining the geographic position of mobile

radio users (GMLC). The central network element then delivers

20   the result back to the location-based service (LCS).

In the solution according to the invention, the freely

selectable region is not restricted to one network operator.

The external location services (LCS) client no longer needs to

25   distribute the inquiry to all network operators offering their

services in this area, this is done for it by the central network element. As long as 3GPP networks are involved, this is a relatively small problem since there is only a small number of these and they are generally known. In the case of

5   the WLAN networks, however, the situation is different since this is a rapidly changing business.

An additional network node is then introduced which contains all network operators and their local radius of operation. The

10   central network element which deals with the interaction of the network operators provides third-party service providers with the opportunity to offer their own small applications inexpensively and rapidly. End users, network operators and application developers will profit from such an approach.

15

The distribution, carried out by the central network element, of functionalities to many connected network nodes which are controlled by different operators supports third-party service providers in offering their services also in areas which are

20   made difficult by technological, administrative or legal boundaries.

These central network elements also solve dynamic problems by reducing the network load and using caches.

25

In accordance with an added feature of the invention, a first
device for determining the geographic position of mobile radio
users is located within an infrastructure of a first mobile
radio network and a second device for determining the

5   geographic position of mobile radio users is located within an
infrastructure of a second mobile radio network.

In accordance with an additional feature of the invention,
upon receiving an inquiry in the central network element, a

10   check is carried out whether a desired result is already
stored as a result of a previous inquiry and the result can be
delivered to the location-based service, or the central
network element must request the desired result from the at
least one device for determining the geographic position of

15   mobile radio users. The process may further provide a result
requested by the central network element from a device for
determining the geographic position of mobile radio users with
an additional identification (e.g., a timestamp and/or
information on an accuracy of the inquiry), and reuse the

20   stored result for one or more further inquiries in dependence
on the additional identification.

In accordance with another feature of the invention, the
method comprises, upon receiving an inquiry in the central

25   network element, first checking whether a desired inquiry has
already been processed or a result of a previous inquiry is

still outstanding, and, after receiving the result of the
previous inquiry, a current inquiry can also be answered.

In accordance with a further feature of the invention, the
5   central network element collects the results of the inquiries
from the at least two devices for determining the geographic
position of mobile radio users and, as soon as all
interrogated devices for determining the geographic position
of mobile radio users have answered, combines the answers and
10   to deliver the result to the location-based service.

In accordance with again an added feature of the invention,
the region of the inquiry comprises a first geographic region
(location area 1) for which a first central network element is
15   responsible, and comprises a second geographic region
(location area 2) for which a second central network element
is responsible. Furthermore, the first central network element
receives an inquiry and forwards this inquiry for the second
geographic region to the second central network element.
20

In accordance with again an additional feature of the
invention, the central network element stores the results of
the inquiries as a list and only delivers the identification
of the list back to the location-based service. Preferably,
25   the central network element is additionally supplied with or
determines by other means characteristics of the subscribers

determined from the devices for determining the geographic
position of mobile radio users, collects these and stores them
for later use, and delivers them back to the location-based
service together with the identification of the list.

5

In accordance with again a further feature of the invention,
the central network element contains a correlation between the
identity of at least one subscriber for whom a location
information is requested and the network node responsible for
10   this subscriber and, if the central network element receives
an inquiry message from the location-based service, it
distributes this inquiry to each identity which is stored for
this network node.

15   With the above and other objects in view there is also
provided, in accordance with the invention, a device for
handling inquiries of a location-based service, for a limited
geographic area (area) which is served by at least two devices
for determining the geographic position of mobile radio users,
20   for a plurality of subscribers in this geographic area. The
novel device includes:

means for receiving inquiries, sent by the location-based
service, about the identity of subscribers in this geographic
area; and

means for sending a request for current information about the subscribers active in the limited geographic area to a device for determining the geographic position of mobile radio users; and

5 means for receiving the answers from the interrogated device for determining the geographic position of mobile radio users; and

means for processing the answers; and

means for sending the result to the location-based service.

10

In accordance with yet an added feature of the invention, the device has a database for storing the answers from the interrogated device for determining the geographic position of mobile radio users and an additional identification of the

15 answers, and means for comparing a new inquiry with the answers already stored.

In accordance with a concomitant feature of the invention, the database stores the answers from the interrogated device for

20 determining the geographic position of mobile radio users and sends an unambiguous identification (unique identifier) of the answers, and the unambiguous identification of the answers is used in subsequent messages from the location-based service.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

5   Although the invention is illustrated and described herein as embodied in a method and a device for handling location-based services, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents

10   of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description

15   of specific embodiments when read in connection with the accompanying drawings.

Brief Description of the Drawings:

Fig. 1 is a block diagram of an existing 3GPP network

20   architecture supplemented in accordance with the invention;

Fig. 2 is an architecture diagram with the local area server LAS;

25   Fig. 3 is an area diagram showing various geographic areas which are supplied by an LAS;

Fig. 4 is a tree structure showing a geographic area covered by a local area server LAS;

5   Fig. 5 is an area diagram showing an example of various independent requirements; and

Fig. 6 is a data exchange flowchart.

10   <u>Description of the Preferred Embodiments:</u>

Referring now to the figures of the drawing in detail and first, particularly, to Fig. 1 thereof, there is illustrated a block diagram showing a basic structure of the architecture of the system.

15

A.   Architecture and Overview

Fig. 1 shows the current 3GPP network architecture as depicted in chapter 5.2.2 of the specification 3GPP TS 23.002 (V5.9.0, 2002-12): Network Architecture. A more detailed description of

20   the network elements and interfaces (Lh, Le, Lc, Lg, Iu, Iur, Iub, Uu, etc.) can also be found there; for that purpose, the specification is herewith incorporated by reference.

In the home location register HLR, entries with respect to subscriber information are assigned to the mobile radio subscriber.

5   The visitor location register VLR is the local register for switching-based services. It is used by the mobile switching center MSC for obtaining information about roaming subscribers, that is to say those from local and other mobile radio operators, staying in the region and for processing

10   their calls.

In contrast, the serving GPRS support node SGSN, is needed for storing subscriber information for packet-oriented services in a mobile radio network.

15

The mobile-services switching center MSC also represents the interface between the mobile radio network and the landline network. The switching center performs all necessary functions for processing circuit-switched services to and from the

20   mobile station.

The gateway mobile location center GMLC is the first network node accessed via a location-based service in a mobile radio network. It performs the authorization and interrogates the

25   home location register HLR for the routing information.

In the text which follows, GMLC also stands for other network nodes such as WLAN access points (also called hotspots), landline network, etc., which form the access for location-based services.

A node B is a logical network component which serves one or more cells. A radio network controller RNC is a network component in the mobile radio network which controls one or more nodes B.

The location measurement unit LMU performs radio measurements in support of locating methods. Two types of LMU are defined, namely:

- type A: access via the normal GSM interface (U_m), there is no wire connection to another network element.

- type B: access via the base station - controller interface (I_{UB}). The LMU can be a stand-alone network element with a pseudo-cell ID or can be integrated in a node B.

The serving radio network controller SRNC coordinates the location inquiries as a function of priority and selects a suitable locating method. It can have an interface to the controlling radio network controller CRNC which mainly has

aids for locating the terminal and interrogates a

corresponding measurement from the network nodes B and LMU.

A description of locating methods may be found, by way of

5   example, in the article "Convex Position Estimation in Wireless

Sensor Networks" by Lance Doherty, Kristofer S.J. Pister, Laufent

El Ghaoui, Infocom 2001, Anchorage, AK, April 2001 (http://www-

bsac.eecs.berkeley.edu/~ldoherty/infocom.pdf).

10   The GSM service control function, gsmSCF, is a functional unit

which contains the CAMEL service logic for implementing

operator-specific services.

The cell broadcast center CBC is responsible for managing CBS

15   (cell broadcast service) messages and conveying CBS messages

to the RNS (Radio Network System).

Only the right-hand part of Fig. 1 is relevant for the present

case. An external LCS client interrogates the network for

20   location information via an L_e interface (3GPP uses the mobile

location protocol MLP (LIF/OMA, TS 101 specification: MLP

Mobile Location Protocol). The position can be interrogated

with defined accuracy for one or more IDs. However, the

protocol can only handle a network which was selected by the

25   external LCS client with the aid of the subscriber ID. In

future, this protocol should also be applicable to international cases.

A new network element, the location area server LAS, and a new
5   protocol, the location area protocol LAP for handling areas, are being introduced. The location area server is located between or next to the external LCS client and the various networks.

10   Fig. 2 shows the new network element location area server LAS and its position in the network. The various mobile radio or WLAN operators can cooperate and use the network element LAS for relieving their own network elements and to integrate various technologies. On the other hand, the LAS can join
15   competing networks and allow external applications to gain access to these networks. The LAS has a database which stores the actual network coverage. Each LAS is responsible for a certain region. The region served by an LAS can be a country, a continent or also a relatively small unit. Furthermore,
20   there is an interLAS protocol between two LASs and a mechanism for selecting the correct LAS. The inquiries received by an external LCS client are not limited to the region covered by a single LAS. Communication with the external LCS client takes place via the location area protocol LAP. This can also be
25   used for communicating with the network nodes GLMC or WLAN

hotspot. Existing standard protocols are also possible but the losses in functionality must be accepted.

Step 0:

5 The prerequisite is the configuration of the LAS. Each LAS contains a table containing addresses of network nodes and of location areas served by the LAS. These entries can be entered statically, for example by an operator, or generated dynamically by a protocol similar to that described in step 1.

10

Step 1:

The location area data in the LAS must be dynamically updated. As soon as a new network node offers its services or the topology changes, this network node informs the next LAS about

15 the new area served. For this purpose, it sends a message

LAP:UPDATE_LOCATION_AREA

to the LAS with added or removed regions, specified, e.g. by a list of coordinates as described, for example, in the MLP protocol. The network node identifier, the address of the

20 network node and the area served are stored there. If the entire area or a part of it is also served by one or more additional LASs, the message is also forwarded to these LASs. The addresses of these additional LASs, together with the network node identifier, are stored for further actions.

25

As soon as the LAS receives a timeout during the transmission of messages to network units, it marks the network as "unavailable" in order to keep its database updated. The LAS forwards this information to all additional LASs affected by

5 the failure of this network unit.

To avoid unnecessary messages, each network node should inform the LAS about whether it is available. For this purpose, a message

10   LAP:OPERATIONAL_AGAIN

is sent to the LAS after a failure.

This mechanism also solves the problem of redundant network elements. If network 1 uses two GMLCs for serving the same

15 area, the two can inform the LAS about the area. The LAS will continue the operation by duplicating all inquiries until one of the GMLCs no longer answers. As soon as the GMLC is operational again, it reports to the LAS and receives copies of the messages again.

20

Step 2:

When the LAS receives the message

                      LAP:AREA_REQUEST

from an external LCS client, which contains a definition of an

25 area, the LAS checks the area and its responsibility. For the parts of the area administered by other LASs it forwards the

inquiries to these LASs. For the part of the area administered by itself, it begins to determine all involved network nodes and their relevant areas.

5   Fig. 3 shows an example of the area served by an LAS. Three network nodes, namely network node [1, 2, 3], have announced the areas served by them (represented, for simplicity, as rectangles). The desired area (an ellipse) is then scanned and split into three areas, namely area [1, 2, 3]. New subareas

10   are formed: subarea 1 consisting of area1 and area2 is used for the network node 1 and subarea 2 consisting of area2 and area3 is used for the network node 2. The network node 3 is not affected by this inquiry.

15   Step 3:

The inquiry received is now forwarded to all selected network nodes, containing only the required subareas. The answers received are routed to the triggering external LCS client, either collected by all network nodes or individually as soon

20   as they arrive depending on the specification in the original inquiry. If a network node does not answer, it is placed in the list of unavailable network nodes (see step 1).

B. Identification

All known protocols inquiring location information such as the MLP (LIF/OMA) need the identity of the subscriber for whom the location information is interrogated. The identity information

5   is available in a variety of formats depending on the technologies used. For example, an Internet address (IP V.4 or IP V.6) looks different from an E.164 number. External LCS clients should not be confronted by these different formats and the LAS advantageously handles the resolution.

10

For interrogated areas, the external LCS client normally does not know the identities of the subscribers. Naturally, it would be best if the network were to solve this problem and provide a protocol which also allows a location interrogation

15   in the case of unknown identity. However, this would also raise a number of concerns with regard to protection of the private sphere if all external LCS clients were allowed to trace the subscribers of a network. In addition, it would lead to large messages with long lists of subscribers. Even if no

20   return of identities were demanded in the inquiry, the answer would have to contain a list of all subscribers with some identification and location and also a list of the subscribers for whom the inquiry was not successful, either because the wanted subscriber is absent or his data protection rules did

25   not allow an inquiry by this external LCS client.

This problem could be solved by a network node operated in a confidential environment, either due to legal authorization or by the network operator himself.

5

The LAS contains a database which contains the correlation between identities and the responsible network nodes.

Step 1:

10   The network nodes update the database in the LAS at intervals with all identities currently served by them, with the aid of

LAP: UPDATE_IDENTITIES.

Step 2:

15   When the LAS receives an inquiry message from the external LCS client

LAP: AREA_REQUESTS

it distributes this inquiry to each identity stored in its database for these network nodes.

20

Step 3:

All successful answers

LAP: AREA_REQUEST_RESP

from subscribers located in this area are forwarded to the

25   external LCS client, either collectively or individually, depending on the requested mode. This relieves the external

location service client, it does not receive any nonrelevant

information, for example about subscribers who are not located

within the requested area but who do exist in the network.

5 If the protocol used between LAS and GMLC (e.g. MLP) does not

allow an area to be specified with sufficient accuracy, the

position of each subscriber must be interrogated individually

and only those who are located within the desired area are

reported back.

10

This procedure is of advantage since the number of inquiries

to the area is reduced if only active identities are used. The

LCS client does not need to know anything about the internal

structure of the identities and the size and number of

15 messages is reduced. The data protection of subscribers who

are not interrogated is also guaranteed in this way since no

data are sent from the LAS to the LCS client.

However, the network must report all subscribers to the LAS.

20 During this process, internal data are forwarded, and the

frequency of use. To solve this data protection problem, LASs

can be cascaded. One is located in the network of the operator

and receives the message

LAP:UPDATE_IDENTITIES

25 and a further LAS links various networks but does not receive

any information about identities.

Advantageous embodiments are possible:

Variant A:

For network nodes serving a large area, it may be advantageous

5 to insert into the message LAP:UPDATE_IDENTITIES specific

location information, for example the 3GPP location area. The

number of LAP:UPDATE_IDENTITIES messages will increase but the

LAS can then only use identities in the requested areas and

thus reduce the number of messages to the respective network.

10

Modified step 1:

The LAS has received internal rules for constructing

identities in dependence on each network used, either

predefined or with the message

15   LAP: UPDATE_LOCATION_AREA

from the GMLC. It then generates each possible identifier or

uses wild card mechanisms which are allowed by this network

for communicating a message (for example "MLP: Triggered

Location Reporting Request") which triggers a return message

20 if the object is registering in the network. If it receives

such a report and this report indicates that the subscriber is

available, it can set a periodic trigger for receiving the

location-based information with somewhat better accuracy, for

example in location areas. Using this standard protocol

25 mechanism, the LAS can fill its database consisting of

identities, network nodes and known location information without requiring any change in the network.

Variant B:

5   There is a number of applications in which the external LCS client does not need to know the identity of the object located. It can be sufficient to send an information item to all objects located. In this case, a relatively small modification of the protocol is also sufficient for solving

10   this problem:

Modified step 3:

On receipt of the answers

LAP: AREA_REQUEST_RESP

15   in the requested areas, the LAS collects all identities together with capabilities and characteristics of terminals used and possibly identifiers for these (for example SMS, WAP, SIP, E-mail addresses, voice mail, speech...). These possibilities and presettings can also be retrieved by the LAS

20   directly from a server keeping these data. A temporary identifier for this list of identities is then sent back to the external LCS client together with statistical information, for example how many subscribers were found, how many of these can use SMS etc.

25

Step 4:

The external LCS client can then address particular parts of
the information, for example a web address, a telephone
number, a short message or the like to this temporary list by
5   using the message

LAP: SUBMIT_INFO.

The LAS can forward this information to all subscribers of
this temporary list in accordance with the user profiles
stored by it.

10

Many of the algorithms described can also be performed by the
external LCS client itself. However, since there is a number
of independent external LCS clients in the network, it would
greatly increase the network loading by means of a
15 multiplicity of messages. It is advantageous, therefore, to
introduce a central network node which is conducted by a
reliable confidential operator. Thus, the networks of various
network operators and various technologies can also be
combined in a simple manner.

20

C.   Dynamic Optimization with AREA_IDENTITY

The areas used by applications are normally symbolically
defined, for example a country, a city, a building or a
shopping mall. Naturally, these areas can be represented by a
25 polygon which consists of a number of points and edges, see,

for example, specification LIF TS 101. It is no problem to calculate whether the position of a sought object is located within a sought polygon. However, this requires an increased computational overhead, especially if it is intended to

5   determine whether the object is crossing a boundary. This requires these calculations to be carried out frequently for a high number of possible objects and for all areas checked which exceeds the limits of performance of current network elements. It is therefore desirable not to calculate such an

10   area in polygons but to define it in other network-specific areas. This can be a subnetwork in the case of WLAN or location areas (LAC) and cells (CI) for 3GPP.

Fig. 4 shows the geographic structure served by an LAS. Its

15   area of responsibility consists of one WLAN and two GMLCs. The GMLC areas, in turn, are covered by one or more MSC-SGSNs. These, in turn, are divided into location areas and the location areas consist of radio cells. Cellular networks are usually built up in such a hierarchical structure. For

20   example, 3GPP is defined in such a manner that an HLR knows the MSC area of a subscriber in which it is currently located. The MSC always knows the last location area of a subscriber. It is only in some cases, for example when a subscriber is currently calling, that the actual cell is known. Otherwise,

25   the precise position of location can only be found by an

explicit inquiry from the radio network or from the subscriber station.

An algorithm for avoiding repeated pollings of the position

5   could look as follows: in the first approximation, a set of location areas LA enclosing the desired area is triggered. If the target object is located in one of these location areas, a locating method with more detailed accuracy can be used, for example on the basis of the radio cells. A more detailed

10 determination may be unnecessary if the required accuracy is not very high or the radio cells are small.

To use the mechanism according to the invention, the desired area given by polygons or a composition of ellipses and

15 rectangles must be converted into location areas. The processing necessary for this can be quite elaborate depending on the size of the area and should be avoided. Changes in network topology should also remain unnoticeable for the external LCS client and be transparent.

20

In the text which follows, a process is thus specified which shows how a desired area is converted once by the LAS and an identifier for this area is delivered back to the external LCS for further use. However, this requires the disclosure of the

25 position of the location areas in the network. This may

present problems since network operators may not wish to
disclose the internal structure of their network.

5   The further action by the LAS depends on the user structure,
whether the LAS belongs to a network operator or acts across
network operators. If the LAS belongs to a number of network
operators, a cascaded structure as described above can be
advantageously chosen. The external client then sends its
inquiry to an LAS belonging to a number of network operators
10   and behaving in accordance with algorithm A. After that, this
LAS sends the inquiry to the LASs within the network operator
according to algorithm B.

Algorithm A - The LAS does not know the internal structure of
15   the network:

Step 1:
The external client sends a message

                    LAP: REQUEST_AREA_IDENTIFIER

20   to the LAS. This message contains the complete definition of
an area.

Step 2:
The LAS processes this area as already described in part A,
25   step 2. During this process, the message

                    LAP: REQUEST_AREA_IDENTIFIER

is forwarded to other LASs if necessary. The result is stored

in the database. It consists of a list of units affected and

the subareas for these units together with the received

identifiers of other LASs. In the case of changes in the

5   network as described in part A, step 1, the data are updated.

Since this updating is necessary only sporadically, a gain in

performance can be expected, in any case.

Step 3:

10   The LAS stores the definition of the area together with the

result obtained, generates an unambiguous name AREA_IDENTITY

and sends it back with the message

        LAP: REQUEST_AREA_IDENTIFIER_RESPONSE.

In the further course of the action, this identifier can be

15   used for external clients and also by other applications

having knowledge of it. Further mechanisms for maintaining

these identifiers, for example discarding the entry if it is

not used within a number of days or forming the checksum are

necessary and known to a person skilled in the art. It can

20   also obtain additional information, for example a readable

designator which describes the nature of this area such as

"shopping center XY" or "city AZ". If the requested area is

already contained in the database of the LAS, the stored

identifier AREA_IDENTITY is delivered back. Advantageously,

25   identifiers already determined by the LAS operator are

predefined, for example cities or countries.

Step 4:

The AREA_IDENTITY determined or defined can then be used for messages such as LAP: AREA_REQUEST as described above. The use of these identifiers can be promoted, for example by charging lower fees or by increased priority in answering the messages.

5

Algorithm B - LAS knows the internal structure of the network:

10 Step 0:

The message

LAP: UPDATE_LOCATION_AREA

as described above, also contains the internal structure of an area dealt with, a list of location areas and optionally also

15 a list of radio cells.

Step 1:

See algorithm A, step 1 above.

20 Step 2:

See step 2 above

In addition, a list of location areas and optionally also of radio cells is stored for each AREA_IDENTITY in the database.

25 Steps 3 and 4:

See step 3 and step 4 above

Naturally, these functionalities can also be physically integrated in the MSC-SGSN.

5   **D. Dynamic Optimization in the Case of**

a Large Number of Clients

The network receives different independent inquiries for different areas from different independent applications located on many external clients. If the network deals with

10 these inquiries independently of one another, it generates a large amount of superfluous traffic. The algorithm described is intended to lead to the expensive locating methods being executed only under certain conditions. It is then determined firstly whether the object is located in location areas, then

15 in cells and it is only when the objected is located within a special cell that the actual locating is carried out.

Step 1:

If it is found that a number of inquiries are made for the

20 same area (this can be determined simply by finding the same AREA_IDENTITY in the inquiries during a comparison), the inquiry can be dealt with by the LAS itself. This is done either by using a result already reported back and temporarily stored in the cache or by waiting for a result already

25 requested but not obtained. The probability of two identical

inquiries from independent applications is very high when a large number of competitors offer the same services or the area is relatively large, for example a city.

5 Step 2:

Even if two inquiries do not deal with absolutely identical areas, the algorithm used can still lead to the same location areas or cells. This concept can be clarified by the following example from Fig. 5. An area is shown which consists of two

10 location areas, location area 1 and location area 2. These location areas, in turn, are divided into radio cells (cell 1.1, cell 1.2, cell 1.3, cell 2.1 etc.). There are various applications which make inquiries in three target areas which partially overlap both the location areas and the radio cells.

15 In this case, there is only a small overlapping area between target area 1 and target area 2. Target area 1 covers location area 1 and location area 2, target area 2 only covers a part of location area 2 and target area 3, in turn, only covers location area 1. If an inquiry for target area 1 is received,

20 this result can also be used later without any further inquiry for target area 2 and target area 3, respectively, without again requesting information from this MSC. For target area 1, the cells cell 2.1, cell 2.2 and cell 2.4 must be requested. These results can be used again later for target area 2.

25

An algorithm could look as follows:

Step 1:

After receiving an instruction

LAP: AREA_REQUEST

the requested area is compared with those which were ended

5   shortly before or the inquiry of which has not been completely

processed yet. If agreements are found during the comparison,

the request just received is answered from the answers already

stored or delayed until the result is available. It must be

taken into consideration that there can be different

10   parameters in the inquiry such as "quality of service"

parameters and accuracy of the inquiry.

Step 2:

After receiving a list of selected network nodes as already

15   described in part A, step 3, or the list of location areas or

cells as described in part C, algorithm B, the LAS can break

down the inquiry into a set of individual operations for

subareas. For each subarea, the inquiry is dealt with as

previously described in step 1. Subareas for which there is no

20   result are collected and the inquiries are then forwarded to

the GMLCs as already described above.

Step 3:

The incoming results of the new inquiries are stored in the

25   cache, together with a timestamp. As soon as all required

information necessary for answering the original inquiry has

been collected, an answer is generated together with the

results from the cache. Optionally, partial results can also

be sent immediately to the external client. This improves the

response times, at least for a part, and distributes the load

5   over time.

The second step can be improved further by means of the

described architecture and databases in the LAS:

If the inquiry AREA_REQUEST allows even answers with greater

10   inaccuracy to be sent back or else with location information,

the timestamp of which is further in the past, LAS can use the

results of earlier inquiries for responding. This lowers the

number of inquiries which must be forwarded to the GMLC.

15   The knowledge of the internal structure of various network

operators can also lower the network load.

Example 1: A roaming subscriber outside his home network can

alternatively register in two visited networks VPLMN1 and

VPLMN2. If the LAS accurately knows the position of the

20   subscriber in VPLMN1 and shortly thereafter there is an

inquiry for VPLMN2, the subscriber has changed to VPLMN2 in

the meantime and only this fact is known to the LAS, the

current position can also be calculated with the required

quality from the exact position from VPLMN1, the time

25   difference and the average speed of the subscriber without

having to carry out a new and more precise location inquiry

from the second visited network VPLMN2.

Example 2: For this purpose, Fig. 3 must be considered again.

5   If it is known that the location had been in network node 1

some time ago and an average speed does not allow the

subscriber to be located already in the network node 3 area,

an inquiry for this can be avoided. Using algorithms which

take into consideration some past positions of the subscriber,

10   the accuracy can also be enhanced without interrogating the

networks. Some algorithms are described in the document by

Lance Doherty et al. already cited above.

Fig. 6 contains a summary of the algorithms. The call-up

15   diagram is only exemplary of some aspects of the invention and

it is not complete, either, since some necessary response

messages have been left out. It shows a location information

server LAS, two application programs external client 1 and 2

with which the LAS communicates via the LAP protocol, two

20   networks with the network elements GMLC1 and GMLC2 with which

the location information server communicates via the LAP-MLP

protocol and a second location information server LAS2 with

which the first LAS communicates via an inter-LAS protocol.

Both of the two independent application protocols want to send

25   an SMS to all subscribers in the same region. This region is

served by the two independent networks represented by GMLC1 and GMLC2.

Messages 1 and 2:

5   GMLC1 and GMLC2 send their location information coordinates of the areas for which they are responsible and optionally the structure and location of the location areas and radio cells to the LAS. In addition, the message can contain a structure of the identities and/or a list of currently active identities

10   in this area.

Message 3:

The LAS is not responsible for a part of the location of GMLC2 which is why the corresponding part of the information is

15   forwarded to LAS2 in a message. This does not appear to be optimal in this small network configuration but it does indicate the flexibility of the protocol.

Message 4:

20   The external client 1 sends an AREA_REQUEST to the LAS, containing a description of the requested area.

Message 5:

A part of this requested area (subarea 0) is not handled by

25   the LAS but by the second location server LAS2. This request is, therefore, forwarded to LAS2.

Message 6:

A standard MLP protocol message as described in OMA is sent to GMLC2. It contains the subarea 1 served by GMLC2, and the

5   identities used by GMLC2.

Message 7:

The same applies to GMLC1.

10   Message 8:

The location server LAS2, too, now sends standard MLP protocol messages for the area served by it and GMLC2 to GMLC2.

Message 9:

15   The second external client 2, too, now sends a location request AREA_REQUEST for the same area as in message 4. The location server LAS takes note of this fact and delays the processing of this message since it is waiting for the answers to the first inquiry (message 4).

20

Message 10:

The location server receives the answers from GMLC1. They may contain a long list of identities and their location information or error messages. This answer is stored until all

25   requested information has arrived or until a timeout occurs.

Message 11:

The same applies to GLMC2.

Message 12:

5   The second location server LAS2, too, is collecting

information.

Message 13:

The second location server LAS2 generates a temporary identity

10   RESP_ID_1 for the collected subscriber identities and an

identifier AREA_ID_1 for this area for later use. These are

sent to the location server LAS.

Message 14:

15   The location server LAS now has all the necessary information,

it also generates a temporary identity RESP_ID_2 and an

identifier AREA_ID_2 for this area for later use. These are

sent to the first external client 1.

20   Message 15:

The location inquiry AREA_REQUEST can now also be answered by

the external client 2. Only information collected by the first

inquiry from the external client 1 is used.

Message 16:

The external client 1 now wants to send a short SMS message to all subscribers located within the area specified before. It therefore sends a SUBMIT_INFO message with the text of the SMS

5   to the location server LAS to the list stored there with the identity RESP_ID_2.

Message 17:

The location server LAS will send the text of this short SMS

10   message to all subscriber identities which it has previously stored from GLMC1. In this case, the target is normally not the GLMC but a network node which is responsible for short messages.

15   Message 18:

The same applies to GMLC2.

Message 19:

The information is now also sent to location server 2 LAS2 by

20   means of SUBMIT_INFO, using RESPOND_ID_1.

Message 20:

Location server 2 LAS2 will also proceed as described in message 17 above.

25

This application claims the priority under 35 U.S.C. § 119 of German patent application No. 103 15 064.1, filed April 2, 2003. The disclosure of the priority application is herewith incorporated by reference in its entirety. MPEP 2163.07 (E8, 2003).